

This Page Is Inserted by IFW Operations
and is not a part of the Official Record

BEST AVAILABLE IMAGES

Defective images within this document are accurate representations of the original documents submitted by the applicant.

Defects in the images may include (but are not limited to):

- BLACK BORDERS
- TEXT CUT OFF AT TOP, BOTTOM OR SIDES
- FADED TEXT
- ILLEGIBLE TEXT
- SKEWED/SLANTED IMAGES
- COLORED PHOTOS
- BLACK OR VERY BLACK AND WHITE DARK PHOTOS
- GRAY SCALE DOCUMENTS

IMAGES ARE BEST AVAILABLE COPY.

**As rescanning documents *will not* correct images,
please do not report the images to the
Image Problems Mailbox.**



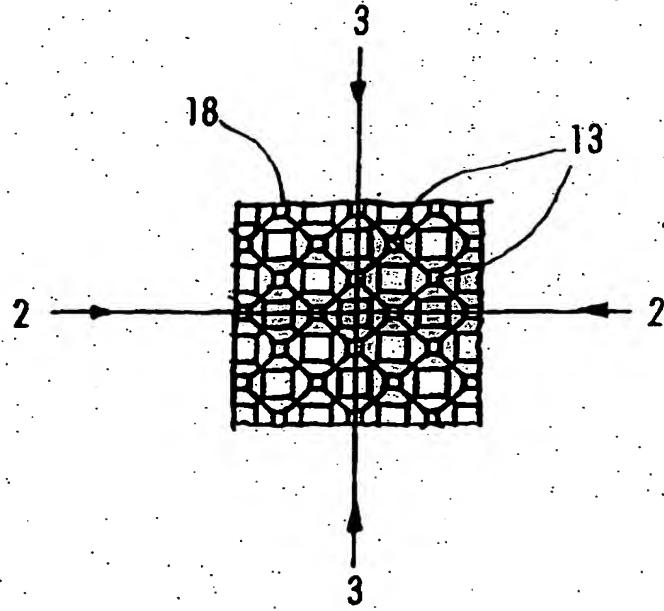
INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 6 : B32B 3/30, B21D 13/02, B32B 31/00, 29/08		A1	(11) International Publication Number: WO 98/08674 (43) International Publication Date: 5 March 1998 (05.03.98)
(21) International Application Number: PCT/IT97/00164		(81) Designated States: CA, JP, KR, US, European patent (AT, BE, CH, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE).	
(22) International Filing Date: 10 July 1997 (10.07.97)		Published <i>With international search report.</i>	
(30) Priority Data: TO96A000724 28 August 1996 (28.08.96) IT TO96A000725 28 August 1996 (28.08.96) IT TO96A000741 10 September 1996 (10.09.96) IT			
(71) Applicant (for all designated States except US): DELTA DI AMIDEI DARIO & C., S.A.S. [IT/IT] ; Via Sabolo, 22, I-10010 Banchette (IT).			
(72) Inventor; and			
(75) Inventor/Applicant (for US only): AMIDEI, Dario [IT/IT] ; Via Sabolo, 22, I-10010 Banchette (IT).			
(74) Agent: CASUCCIO, Carlo; Ing. C. Olivetti & C., S.p.A., Via G. Jervis, 77, I-10015 Ivrea (TO) (IT)			

(54) Title: **MULTI-LAYER CELLULAR COMPOSITE FLAT PANEL**

(57) Abstract

A multi-layer cellular composite flat panel (18) comprises a couple of external plates or sheets essentially parallel to and spaced apart from each other, made of a variety of different materials according to the final use of the panel itself, and an internal cellular structure fixed to and between said external plates or sheets defining substantially a plane; said internal cellular structure comprises either a single compact diamond-embossed sheet or film of a suitable material, having a multiplicity of small scale tridimensional relieves and dépressions (13) distributed with uniform pitch (p) in substantially mutually perpendicular directions in the plane, or a plurality of said compact diamond-embossed sheets or films; with or without interleaved intermediate flat sheets, superposed one upon the other and made integral in rigid and permanent manner.



FOR THE PURPOSES OF INFORMATION ONLY

Codes used to identify States party to the PCT on the front pages of pamphlets publishing international applications under the PCT.

AL	Albania	ES	Spain	LS	Lesotho	SI	Slovenia
AM	Armenia	FI	Finland	LT	Lithuania	SK	Slovakia
AT	Austria	FR	France	LU	Luxembourg	SN	Senegal
AU	Australia	GA	Gabon	LV	Latvia	SZ	Swaziland
AZ	Azerbaijan	GB	United Kingdom	MC	Monaco	TD	Chad
BA	Bosnia and Herzegovina	GE	Georgia	MD	Republic of Moldova	TG	Togo
BB	Barbados	GH	Ghana	MG	Madagascar	TJ	Tajikistan
BE	Belgium	GN	Guinea	MK	The former Yugoslav Republic of Macedonia	TM	Turkmenistan
BF	Burkina Faso	GR	Greece	ML	Mali	TR	Turkey
BG	Bulgaria	HU	Hungary	MN	Mongolia	TT	Trinidad and Tobago
BJ	Benin	IE	Ireland	MR	Mauritania	UA	Ukraine
BR	Brazil	IL	Israel	MW	Malawi	UG	Uganda
BY	Belarus	IS	Iceland	MX	Mexico	US	United States of America
CA	Canada	IT	Italy	NE	Niger	UZ	Uzbekistan
CF	Central African Republic	JP	Japan	NL	Netherlands	VN	Viet Nam
CG	Congo	KE	Kenya	NO	Norway	YU	Yugoslavia
CH	Switzerland	KG	Kyrgyzstan	NZ	New Zealand	ZW	Zimbabwe
CI	Côte d'Ivoire	KP	Democratic People's Republic of Korea	PL	Poland		
CM	Cameroon	KR	Republic of Korea	PT	Portugal		
CN	China	KZ	Kazakhstan	RO	Romania		
CU	Cuba	LC	Saint Lucia	RU	Russian Federation		
CZ	Czech Republic	LI	Liechtenstein	SD	Sudan		
DE	Germany	LK	Sri Lanka	SE	Sweden		
DK	Denmark	LR	Liberia	SG	Singapore		
EE	Estonia						

- 1 -

TITLE

"MULTI-LAYER CELLULAR COMPOSITE FLAT PANEL"

5

TEXT OF THE DESCRIPTION

Field of the invention - The present invention relates to a multi-layer cellular composite flat panel to be used in many different industrial sectors, such as building, packaging or furnitures.

10 Related Technological Art - Cellular composite flat panels are known, comprising a couple of external plates and an internal cellular structure, made integral with the external plates in a permanent manner.

15 For example, single-layer and multilayer corrugated cardboards are known wherein one or more sheets of corrugated paper with a certain distance between the 'waves' of the relief pattern are stuck to two outer sheets of flat paper in order to substantially give the whole a mechanical resistance to bending/torsional stresses; these types of corrugated cardboard offer a resistance to bending/torsional stress and to bending that is decidedly dissimilar at 90° across the plane. If the mechanical 20 stresses of bending are parallel to the 'waves' of the corrugated cardboard, the resistance offered is considerably lower than when stress or bending occur along a direction that is perpendicular to the 'waves' of the corrugated cardboard.

25 Similarly, multi-layer panels are known that are made from wood and wood derivatives such as plywood, particle board, multilayer, "Faesite", etc; also known are panels made using the sandwich technique, whereby an element such as polystyrene foam is placed between two elements of wood or wood derivatives to produce insulating panels used, for example, in the construction of caravans, or whereby a space is 30 created using cardboard elements, such as in doors for modular-unit kitchens: panels of these types have limitations related to their cost and

weight or may be dangerous because of the noxious gases released by the foam in the event of the construction going on fire.

Finally, panels, known as plaster board, comprising a filler space of corrugated cardboard and two outer layers of plaster are known and used in the building trade; also known is a material for covering made by joining a thin sheet of marble to a compact metal sheet using an adhesive.

All the foregoing known multi-layer panels have the disadvantage of offering a resistance to bending/torsional stress and to bending that is not even across the plane; or, when the internal cellular structure is of the honeycomb type, of having a cost per reference unit, for example per square metre, that is high, with the result that use thereof has been limited to special, not widespread applications.

Summary of the invention - One object of the present invention is therefore to define a multi-layer cellular composite flat panel, wherein it comprises an internal cellular structure consisting of at least one compact plate or sheet of a material (e.g. a metal, a metal alloy, a synthetic thermoplastic resin, or a sheet of paper or cellulose derivatives) of suitable thickness and characteristics, diamond-embossed to give a substantially 'hills' and 'valleys' type profile in which small, uniform type cells are created; and a couple of flat, external plates or sheets, of a material than can be paper, with or without an external face coated with plastic or metal films, particularly polythene or aluminium; or wooden, plywood, treated or otherwise, particle board, treated or otherwise, wood-derivative panels; or building materials with functions of covering, such as marble, granite, stone of various types, or ceramic materials, or trowelled covering materials such as Scagliola plaster, gypsum plaster, lime putty, or materials used substantially with structural functions, such as concrete of various types, clay tiles, expanded clay, etc.; all the foregoing external plates being of suitable thickness and permanently joined to the internal cellular structure, by means of strong bonding processes to produce a complete cellular panel.

These cells are of dimensions, shape and distance apart that are

consistent with resistance to the bending/torsional stress whereto the cellular structure is subjected when rigidly and permanently coupled with the couple of flat, external sheets or plates, so as to constitute a whole multi-layer cellular composite flat panel.

5 The above objects are achieved by means of a multi-layer cellular composite flat panel according to the main claim.

These and other objects, characteristics and advantages of the present invention will become apparent in the course of the following description of preferred embodiments, provided as a non-exhaustive 10 examples, taken in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF DRAWINGS

Fig. 1 represents a plan view in an arbitrary scale of a part of the internal 15 cellular structure of the multi-layer cellular composite flat panel according to the invention.

Fig. 2 represents a cross-sectional view in an arbitrary scale of the internal cellular structure of Fig. 1 along a line 2-2.

Fig. 3 represents a cross-sectional view in an arbitrary scale of the 20 internal cellular structure of Fig. 1 along a line 3-3, perpendicular to the line 2-2.

Fig. 4 represents a cross-sectional view in an arbitrary scale of the complete multi-layer cellular composite flat panel with a single-layer internal cellular structure according to a first embodiment of 25 the invention.

Fig. 5 represents a cross-sectional view in an arbitrary scale of the complete multi-layer cellular composite flat panel with a two-layer internal cellular structure according to a second embodiment of the invention.

30 Fig. 6 represents a cross-sectional view in an arbitrary scale of the complete multi-layer cellular composite flat panel with a three-

- 4 -

layer internal cellular structure according to a third embodiment of the invention.

Fig. 7 represents a cross-sectional view in an arbitrary scale of the complete multi-layer cellular composite flat panel with a four-layer internal cellular structure according to a fourth embodiment of the invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

10 A cross-sectional view of a first embodiment of the multi-layer cellular composite flat panel of the invention is represented in Fig. 4, in which a three-layer cellular panel 10 is composed by a first external plate or sheet 16 and a second external plate or sheet 17, essentially parallel to and spaced apart from each other; and an internal single-layer cellular 15 structure, fixed to and between the first external sheet 16 and the second external sheet 17, defining substantially a plane and consisting of a single compact sheet or film 18 (Fig. 1) showing a diamond-embossed profile having a multiplicity of small scale tridimensional relieves (or 'hills') and depressions (or 'valleys'), forming in combination a multiplicity of cells 13, 20 distributed with a uniform pitch p in substantially mutually perpendicular directions in the plane.

The plan section shape of the single cells 13 can be circular or polygonal, in particular can be substantially squared as shown in Fig. 1 as illustrative example; the embossing creates a tridimensional impression, 25 having sharp or rounded edges, of a total height h , as shown in Figs. 2 and 3, which represent in an arbitrary scale cross-sectional views of the diamond-embossed sheet 18 in two mutually perpendicular direction 2-2 and 3-3. The preferred values for h range from 0,1 to 60 mm, best from 0,5 to 50 mm.

30 In order to obtain the best results, preferred values higher than or equal to 1 of the ratio p/h of the pitch p and the height h are employed, a value p/h substantially equal to 2 being the best value.

The criss-crossing 'hills' and 'valleys' of the diamond-embossing profile of the compact diamond-embossed sheet 18 (Fig. 1) are obtained by means of a suitable, conventional forming process according to the nature of the material of which the compact diamond-embossed sheet 18 is made; examples of the forming process are a cold plastic deformation process, or a coining process, or a hot plastic deformation process, or an embossing process, or a hot roll-forming process. In particular, the compact diamond-embossed sheet 18 can be produced, as a non-limiting examples, by vacuum hot molding a sheet made of a synthetic thermoplastic resin; or by conveying a single compact sheet of steel into the nip between a couple of forming rolls in an automatic roll forming machine of conventional design.

The cells 13 are suitably spaced apart and are so shaped as to enable the compact diamond-embossed sheet or film 18 be joined permanently to the two external plates or sheet 16, 17 of suitable thickness and characteristics in order to form the complete cellular composite flat panel 10; the special shape assumed by the cellular structure in the cellular composite flat panel 10 of this invention, with a double configuration of finely spaced 'hills' and 'valleys', and the small uniform nature of the cells 13 permits a very high number, preferably as high as approximately 100 per square centimeter, of fixing bridges between the first external plate 16, or the second external plate 17, and the compact diamond-embossed sheet 18, giving the three-layer cellular panel 10 a high mechanical resistance combined with a light weight.

The materials of which the sheet 18 is made can be a metal sheet (as non-limiting examples a steel sheet, a stainless steel sheet, an aluminium sheet, an aluminium alloys sheet, a titanium sheet, a titanium alloys sheet, a copper sheet, or a copper alloys sheet); a synthetic thermoplastic resin sheet (as non-limiting examples a polypropylene sheet or film, a polyethylene sheet or film, a polyvinyl sheet or film, a polyamide sheet or film, a polycarbonate sheet or film, or a polystyrene sheet or film); or a sheet of paper or cellulose derivatives.

Depending on the nature of the materials to be joined, it is possible to use a conventional coupling process for joining the first external sheet 16 and the second external sheet 17 to the compact diamond-embossed sheet 18 of the type of, as non-limiting examples, resistance projection welding, or electric welding, or laser welding, or spot welding, or ultrasonic welding, or hot pressure welding, or diffusion bonding, or soldering, or brazing, or press bonding, or adhesive bonding.

A cross-sectional view of a second embodiment of multi-layer cellular composite flat panel of the invention is represented in Fig. 5, in which a four-layer cellular panel 20 is composed by the first external plate or sheet 16 and the second external plate or sheet 17, essentially parallel to and spaced apart from each other; and an internal dual-layer cellular structure, fixed to and between the first external plate 16 and the second external plate 17, defining substantially a plane and consisting of a couple of the compact diamond-embossed sheet 18 (Fig. 1), showing a diamond-embossed profile having a multiplicity of small scale tridimensional relieves and depressions, forming in combination a multiplicity of cells 13, distributed with the uniform pitch p in substantially mutually perpendicular directions in the plane.

The two compact diamond-embossed sheets 18 constituting the internal dual-layer cellular structure are superposed and made integral in rigid and permanent manner using a conventional coupling process according to the material of which they are made, for example of the type of resistance projection welding, or electric welding, or laser welding, or spot welding, or ultrasonic welding, or hot pressure welding, or diffusion bonding, or soldering, or brazing, or press bonding, or adhesive bonding.

A cross-sectional view of a third embodiment 30 of multi-layer cellular composite flat panel of the invention is shown in Fig. 6, and represents a variation with respect to the previous embodiment, in that an intermediate sheet 15 is inserted between the couple of the compact diamond-embossed sheets 18 and is made integral with them in permanent manner.

A cross-sectional view of a fourth embodiment of multi-layer cellular composite flat panel of the invention is represented in Fig. 7, in which a six-layer cellular panel 40 is composed by the first external plate or sheet 16 and the second external plate or sheet 17, essentially parallel to and spaced apart from each other; and an internal four-layer cellular structure, fixed to and between the first external plate 16 and the second external plate 17, defining substantially a plane and consisting of four compact diamond-embossed sheet 18 (Fig. 1), each showing a diamond-embossed profile having a multiplicity of small scale tridimensional relieves and depressions, forming in combination a multiplicity of cells 13, distributed with the uniform pitch p in substantially mutually perpendicular directions in the plane, superposed and made integral in rigid and permanent manner using a conventional coupling process according to the material of which they are made, of the type described before.

It has been discovered that considerable improvements is obtained with the foregoing multi-layer cellular composite flat panels in accordance with the present invention, both of physical characteristics such as lower weight and improved thermal and acoustic insulation, and in view of the lower production costs of the semifinished product, enabling numerous competitive advantages in industrial applications to be obtained with respect to the existing solutions.

Now a description of the industrial applications of the multi-layer cellular flat panel of the invention will be given in various industrial sectors, in view of the materials of which they are made.

In the case in which the internal cellular structure, comprising one or more compact diamond-embossed sheets 18, is made from a sheet of paper or cellulose derivatives, coupled with the first external sheet 16 and the second external sheet 17 sheets similarly made of paper or cellulose derivatives by binding with an adhesive, a multi-layer cellular cardboard with improved characteristics over traditional corrugated cardboard is formed.

The advantages of the foregoing multi-layer cellular cardboard are not limited solely to that of the substantially uniform resistance to bending/torsional stress through a 360° plane, but also include the possibility of making bends along any direction whatsoever, so that shapes and solutions are possible for the product packs and wrappings made from it that are completely new and different from those constructed up to now using traditional corrugated cardboard.

The internal cellular structure may consist of a single compact diamond-embossed sheet 18, as displayed in Fig. 4, or of a couple of compact diamond-embossed sheets 18, directly superposed and coupled together as displayed in Fig. 5, or having an intermediate sheet, as displayed in Fig. 6, similarly made of paper or cellulose derivatives, in order to increase the resistance to bending/torsional stress. Of course, the number of compact diamond-embossed sheets 18, and correspondingly the number of possible intermediate sheets, can be increased without exiting from the scope of the invention.

The shape assumed by the internal cellular structure in the three-layer cellular cardboard of this invention also enables creation of cellular paperboard, that is to say of a three-layer cellular cardboard very thin, in which the pattern of the compact diamond-embossed sheets 18 shows very finely spaced-apart 'hills' and 'valleys' and very low thickness. To advantage, the three-layer cellular paperboard of this industrial invention may, on account of its lower weight for similar resistance values, replace the compact paperboard used for the wrapping of loose foodstuffs and for the packaging of products in general.

With the structure of the three-layer cellular paperboard offering excellent thermal resistance, this semifinished product is particularly suitable for the packaging of frozen products, both because it maintains the temperature inside and also because the paperboard does not become wet on account of the insulation barrier with respect to the external sheet of paper represented by the internal cellular structure. In addition, the three-layer cellular paperboard of the invention, with

polythene-coated or aluminized external paper sheets, that is to say when polythene or aluminium films have been applied to the external paper sheets, may to advantage replace the compact, polythene-coated or aluminized paperboard used in the conventional type packs for the 5 packaging of beverages and other liquids.

In the case in which the internal cellular structure, comprising one or more compact diamond-embossed sheets 18 and possible intermediate sheets, is made from a sheet or film of suitable thickness and material, coupled with the first external plate or sheet 16 and the second external 10 plate or sheet 17, both substantially thin and made of wood or wooden derivatives by a suitable strong binding process, as, for example, binding with an adhesive, a complete wooden or wood-derivative cellular multi-layer composite panel is obtained.

To advantage, the wooden or wood-derivative cellular multi-layer 15 composite panel in its ranges of thicknesses may, on account of its lower weight for similar resistance to bending/torsional stresses, and also of its improved thermal and acoustic insulation, replace the conventional compact type panels made of wood, plywood, particle board, multilayer, medium density fiber board, "Faesite", etc.; it is known, for example, that 20 compact particle board panels are difficult to use for making doors in the furniture industry on account of their being too heavy. The wooden or wood-derivative cellular multi-layer composite panels may also be used to advantage in the construction of caravans and of the partitions used in the building and interior-decoration sectors to replace the conventional foam 25 sandwich panels, offering greater safety in the event of fire and permitting better utilization of the joining methods.

In the case in which the internal cellular structure, comprising one or more compact diamond-embossed sheets 18, is made from a sheet or film of suitable thickness and material, coupled with the first external plate 30 16 and the second external plate 17, both substantially thin and made of building material by a suitable strong binding process, as, for example,

binding with an adhesive, a complete building material cellular multi-layer composite panel is obtained.

By building materials are meant materials used substantially with functions of covering, such as marble, granite, stone of various types, or 5 ceramic materials, or trowelled covering materials such as Scagliola plaster, gypsum plaster, lime putty, or materials used substantially with structural functions, such as concrete of various types, clay tiles, expanded clay, etc.

10 Building material cellular multi-layer composite panels have two principal areas of application in both the traditional building sector and that of prefabricated constructions. The first area of application is for substantially aesthetic type, building material cellular panels in the sector of coverings, both of outer vertical walls and of inner vertical walls, and of coverings for false ceilings, where the traditional materials used today have functional shortcomings; the building material cellular multi-layer 15 composite panels used for this type of application will generally, but not exclusively, be three-layer type.

20 The second area of application for building material multi-layer composite cellular panels, made of both aesthetic and structural materials depending on the degree of finishing required, is in the semistructural sector for the construction of internal walls and separator systems, characterized by being low-weight, highly rigid and with optimum thermal and acoustic insulating properties; generally, but not exclusively, building 25 material multi-layer composite cellular panels having an internal cellular structure of two or more compact diamond-embossed sheets 18 and possibly intermediate sheets, will be used for these purposes.

30 In the field of fire prevention applications, considerable advantage may be obtained from using internal cellular structures made from fire retardant materials that have good thermal and acoustic insulation properties, rather than the types of insulation made from polystyrene foam that are pollutant in the event of fire.

Naturally variants, additions or changes may be made to the present invention by persons skilled in the sector art.

In short, while adhering to the principle of this invention, details of the design and the forms of embodiment described and illustrated in the foregoing may be amply modified without exiting from the scope of the invention.

- 12 -

CLAIMS

1. A multi-layer cellular composite flat panel comprising:
 - a first external plate or sheet and a second external plate or sheet
 5. essentially parallel to and spaced apart from each other; and
 - an internal cellular structure fixed to and between said first external plate or sheet and said second external plate or sheet defining substantially a plane,
characterized in that said internal cellular structure comprises a compact
 10. diamond-embossed sheet or film having a multiplicity of small scale tridimensional relieves and depressions distributed with uniform pitch p in substantially mutually perpendicular directions in said plane.
2. Panel according to claim 1, characterized in that said internal cellular structure comprises a plurality of said compact diamond-embossed sheet or film, superposed one upon the other and made
15. integral in rigid and permanent manner.
3. Panel according to claim 1, characterized in that said internal cellular structure comprises a couple of said compact diamond-embossed sheet or film, and an intermediate flat sheet inserted between said couple of said compact diamond-embossed sheets, superposed one upon the others and made integral in rigid and permanent manner.
20. 4. Panel according to claim 1, 2 or 3, in which said small scale tridimensional relieves and depressions have a total height h , characterized in that said total height h has a value of between 0,1 and 60 mm.
25. 5. Panel according to claim 4, characterized in that said total height h has a value of between 0,5 and 50 mm.
6. Panel according to claim 4, characterized in that the ratio p/h of said pitch p and said total height h has a value equal or higher than 1.
30. 7. Panel according to claim 6, characterized in that said ratio p/h of said pitch p and said total height h has a value approximately equal to 2.
8. Panel according to claim 1, 2 or 3, characterized in that said

compact diamond-embossed sheet or film is made of a material selected from the group consisting of paper and cellulose derivatives.

9. Panel according to claim 8, characterized in that said first external plate or sheet and said second external plate or sheet are obtained from a sheet made of a material selected from the group consisting of paper, cellulose derivatives, polyethylene film coated paper, aluminium film coated paper and polypropylene film coated paper.

10. Panel according to claim 1, 2 or 3, characterized in that said compact diamond-embossed sheet or film is made of a metal selected from the group consisting of steel, stainless steel, aluminium, aluminium alloys, titanium, a titanium alloys, copper, and copper alloys.

11. Panel according to claim 1, 2 or 3, characterized in that said compact diamond-embossed sheet or film is made of a synthetic thermoplastic resin selected from the group consisting of polypropylene, polyethylene, polyvinyl, polyamide, polycarbonate and polystyrene.

12. Panel according to any of claims 1, 2, 3, 8, 10 and 11, characterized in that said first external plate or sheet and said second external plate or sheet are made of a material selected from the group consisting of wood, plywood, particle board, multilayer, medium density fiber board and "Faesite".

13. Panel according to any of claims 1, 2, 3, 8, 10 and 11, characterized in that said first external plate or sheet and said second external plate or sheet are made of a material selected from the group consisting of aesthetic type building materials and structural type building materials.

14. Panel according to claim 13, characterized in that said first external plate or sheet and said second external plate or sheet are made of a material selected from the group consisting of marble, granite, stone, glass, ceramic, concrete, foamed clay and clay tile.

15. Panel according to claim 13, characterized in that said first external plate or sheet and said second external plate or sheet are made of a

- 14 -

material selected from the group consisting of scagliola plaster, gypsum plaster and lime putty.

16. Panel according to claim 1, 2 or 3, characterized in that said multiplicity of small scale tridimensional relieves and depressions is obtained by means of a forming process selected from the group consisting of roll forming, cold plastic deformation, coining, hot plastic deformation, embossing, hot roll-forming, and vacuum hot molding.
17. Panel according to claim 16, characterized in that said forming process is continuous and automatic.
18. Panel according to claim 1, 2 or 3, characterized in that said internal cellular structure is fixed to said first external plate or sheet and to said second external plate or sheet by means of a coupling process selected from the group consisting of resistance projection welding, electric welding, laser welding, spot welding, ultrasonic welding, hot pressure welding, diffusion bonding, soldering, brazing, press bonding, and adhesive bonding.
19. Panel according to claim 2, characterized in that said plurality of compact diamond-embossed sheet or film is made integral by means of a coupling process selected from the group consisting of resistance projection welding, electric welding, laser welding, spot welding, ultrasonic welding, hot pressure welding, diffusion bonding, soldering, brazing, press bonding, and adhesive bonding.
20. Panel according to claim 3, characterized in that said couple of compact diamond-embossed sheet or film and said intermediate flat sheet are made integral by means of a coupling process selected from the group consisting of resistance projection welding, electric welding, laser welding, spot welding, ultrasonic welding, hot pressure welding, diffusion bonding, soldering, brazing, press bonding, and adhesive bonding.
21. Panel according to claim 18, 19 or 20, characterized in that said coupling process is continuous and automatic.

1/2

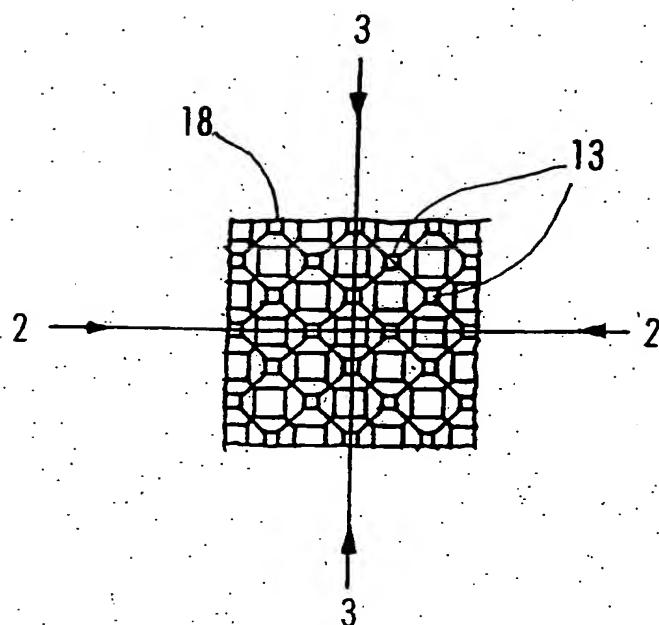


FIG. 1

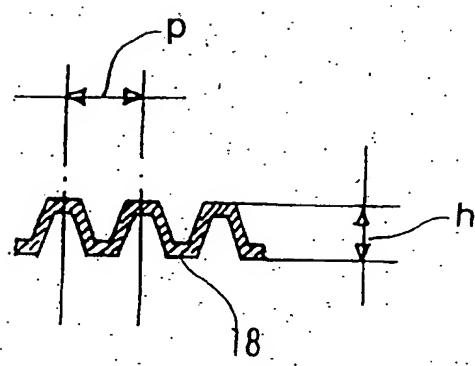


FIG. 2

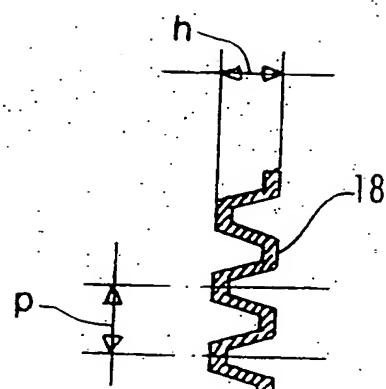


FIG. 3

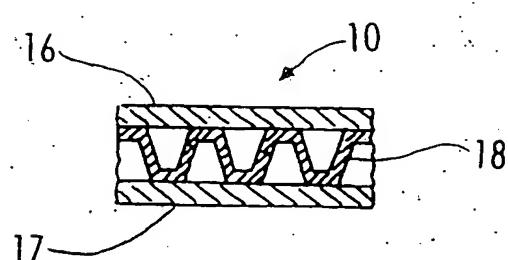


FIG. 4

2/2

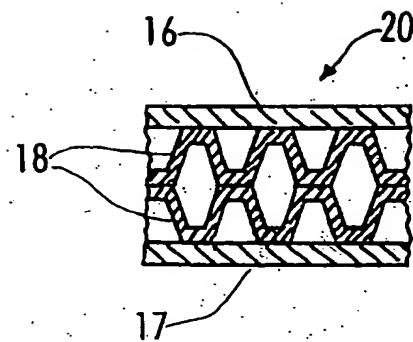


FIG. 5

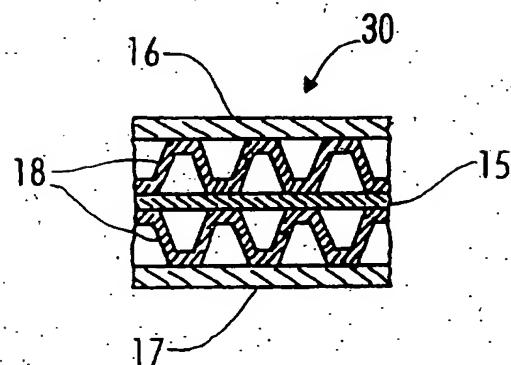


FIG. 6

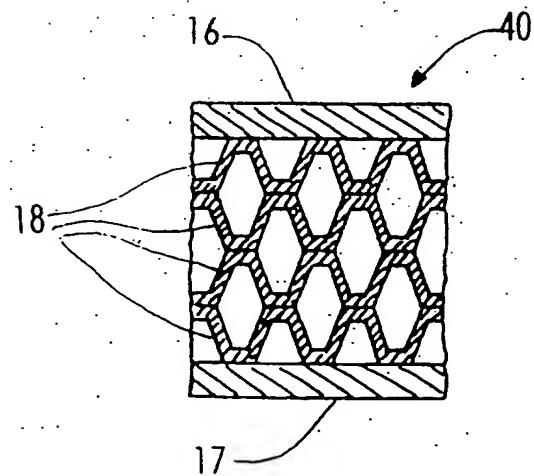


FIG. 7

INTERNATIONAL SEARCH REPORT

International Application No

PCT/IT 97/00164

A. CLASSIFICATION OF SUBJECT MATTER

IPC 6 B32B3/30 B21D13/02 B32B31/00 B32B29/08

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 6 B32B B21D

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 4 025 996 A (SAVEKER DAVID R) 31 May 1977	1, 10-14, 16, 18
A	see column 3, line 43-59 - column 5, line 2-4; claims 1,2,6; figures 1,4 see column 5, line 19-37 - column 6, line 3-6; example	8
X	US 5 156 327 A (TAKAHASHI AKIO ET AL) 20 October 1992	1, 10, 16, 17
A	see column 2, line 12-15 - column 3, line 8-28; claims 1,3; figures 2B,,4 see column 4, line 8-10	4, 5
X	EP 0 144 870 A (MUNZ ERICH) 19 June 1985	1, 4, 6, 10, 16, 18
Y	see page 5, line 17-18 - page 6, line 11; claims 1,2; figures 1,2,7	8-11, 16, 17
		-/-

Further documents are listed in the continuation of box C.

Patent family members are listed in annex.

* Special categories of cited documents:

- "A" document defining the general state of the art which is not considered to be of particular relevance
- "E" earlier document but published on or after the international filing date
- "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
- "O" document referring to an oral disclosure, use, exhibition or other means
- "P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

1

Date of the actual completion of the international search

14 November 1997

Date of mailing of the international search report

28/11/1997

Name and mailing address of the ISA

European Patent Office, P B. 5818 Patentlaan 2
NL - 2280 HV Rijswijk
Tel. (+31-70) 340-2040, Tx. 31 651 epo nl
Fax: (+31-70) 340-3016

Authorized officer

Derz, T

INTERNATIONAL SEARCH REPORT

International Application No

PCT/IT 97/00164

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	DE 27 25 201 A (RENGO CO.) 15 December 1977 see claims 1,5; figure 2; examples	1,8,9
Y	DE 16 02 609 A (FREIH. V. WELSER) 4 February 1971 see page 3, last paragraph - page 4, line 11; claims 1,3,4,6; figures 2,4	1,10,11, 16,17
A	GB 2 194 808 A (DONN INC) 16 March 1988	4,5

INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No

PCT/IT 97/00164

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 4025996 A	31-05-77	US 3992835 A	23-11-76
US 5156327 A	20-10-92	JP 3285726 A GB 2244222 A, B	16-12-91 27-11-91
EP 0144870 A	19-06-85	DE 3442523 A JP 60151500 A	05-06-85 09-08-85
DE 2725201 A	15-12-77	JP 1270118 C JP 52148397 A JP 58034298 B AT 357020 B AU 505005 B AU 2570977 A CA 1082088 A CH 623094 A FR 2353678 A GB 1542765 A NL 7706140 A; B, SE 442182 B	25-06-85 09-12-77 26-07-83 10-06-80 08-11-79 07-12-78 22-07-80 15-05-81 30-12-77 28-03-79 07-12-77 09-12-85
DE 1602609 A	04-02-71	NONE	
GB 2194808 A	16-03-88	US 4753058 A AU 588209 B AU 7817287 A DE 3729854 A FR 2603930 A HK 30095 A JP 63107648 A KR 9604995 B US 4856175 A ZA 8706499 A	28-06-88 07-09-89 17-03-88 17-03-88 18-03-88 10-03-95 12-05-88 18-04-96 15-08-89 01-03-88